be well into V&V by November, and possibly TAG-1 and TAG-3 as well. TAG-6 and TAG-7 are expected to take more time. TAG-6 has linked its schedule to the activities of TR41.6, and should complete its work shortly after TR41.6 completes its work on a DECT-based air interface for wireless PBXs.

Given the above, it is possible that balloting of some of the TR/TSB Standards will begin as early as year-end 1994. The balloting process can be characterized in three parts: filling out sand returning the ballot; comment resolution (if necessary); and reaffirmation of ballot results as a result of comment resolution (if necessary).

A period of approximately six weeks is required for filling out and returning the ballot. Comment resolution continues until it has been determined that comments have been sufficiently resolved. This is not expected to take longer than eight weeks (sufficient time for the JTC to convene twice). However, comment resolution could take longer, or could take considerably shorter. If substantive changes are made during comment resolution, an additional four-week period is required to allow for reaffirmation or change of the ballot as a result of comment resolution.

Usually, a draft text is sufficiently stable when a document goes to ballot, so that a manufacturer can be reasonably comfortable in proceeding with the final aspects of product development. Assuming balloting occurs early 1995, there is a potential for product in small quantities to become available toward the end of 1995, and initial deployment of PCS in 1996.

The JTC reduced the number of air interface proposals from sixteen to seven. The first of these proposals has completed draft text; most of the other proposals are near completion. Balloting of at least one proposal may begin as soon as year-end 1994, and potential product availability may be as soon as late 1994.

Summary

Two major standards developing organizations, Committee T1 and TIA, have been addressing the development of PCS standards for the past three-to-four years. To facilitate standards development of PCS air interfaces, these two organizations established the JTC on Wireless Access. A JEM was conducted to develop high-level requirements to form the basis from which the JTC could perform its task. The JTC reduced the number of air interface proposals from sixteen down to seven. The first of these proposals has completed draft text, and most of the other proposals are near completion of draft text. Balloting of at least one proposal may begin as soon as year-end 1994, and potential product availability may be as soon as late 1994.

References

[1] Second Report and Order, ET Docket No. 92-9, 7 FCC Rcd 6886 (1992) at App. A, §99.5.

[2] Memorandum Opinion and Order, GEN Docket No. 90-314, June 9, 1994, §2.

[3] Standards Project Proposal - Standards for Interfaces Associated with Wireless Access to the Public Telephone and Data Networks, Feb. 21, 1991.

[4] TIA MCD Microcell/PCS Ad-Hoc Committee Final Report, April 11, 1991

[5] TIA Mobile & Personal Communications Division - ANSI-Accredited Standards Organization & ANSI-Accredited Standards Committee T1 - Telecommunications Statement of Cooperation, Sept. 9, 1993.

[6] Report on the Joint Experts' Meeting on PCS Air Interface Standards, Nov. 9-13, 1992, Reston, VA.

[7] JTC Mission and Scope, JTC(AIR)/94.02.07-012R1

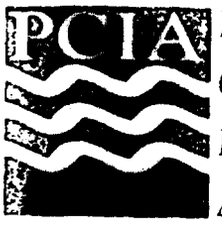
[8] Report on the Joint Experts' Meeting on PCS Air Interface Standards, Nov. 9-13, 1992, Reston, VA, §3.3.3.1.

[9] Choosing the Best Technology, Presented by Graham Haddock, Motorola, National Engineering Consortium WPC Teleforum III, June 9, 1994.

Biography

CHARLES I. COOK was graduated with honors from Brigham Young University with a B.S. in electrical engineering and minors in mathematics and Korean. He received his Master's degree in electrical engineering from Cornell University. He has been active in the development of American National Standards for Physical-Layer access interfaces to the Public Switched Telephone Network (PSTN) since 1987. From 1988 to 1990 he served as secretary of T1E1.4, in 1990 he was elected to a two-year term as vice chair, in 1992 he was elected as chair of T1E1.5, and currently he is chair of T1P1.4 and co-chair of the Joint Technical Committee (JTC) on Wireless Access. He also co-chaired the November 1992 JEM on Air Interface Standards, and has participated in T1E1, T1P1, T1M1, TR45, TR46 and ITU-RS TG 8/1. He is employed by U S WEST Technologies, Boulder, Colorado, and is currently involved in PCS standards activities, strategy development, and technology trials.

EXHIBIT 4



1994 PCS Market Demand Forecast

Personal Communications Industry Association

January 1994

Nineteenth Street, NW • Suite 1100 • Washington, DC 20036-5125 • Tel: 202-467-4770 Fax: 202-467-4658

Introduction

The introduction of cellular service in late 1983 was a cannon shot in the second revolution in communications - mobility. By 1992, over 15 million Americans used pagers and over 11 million used cellular telephones. In the fall of 1993, another shot could be heard as the FCC announced the structure of the new Personal Communications Services (PCS) industry.

New PCS will combine with existing services such as cellular and paging to fundamentally change the way millions of Americans communicate. By 2003, we predict over 52 million subscriptions for cellular telephones, 65 million subscriptions for paging and messaging services, and 31 million subscriptions for New PCS. Additional tools such as mobile satellite terminals, special mobile data services, and advanced dispatch services will also help our diverse economy communicate without the constraints of wires. In sum, this study forecasts 167 million subscriptions to PCS services by 2003.

The Personal Communications Industry Association (formerly Telocator), conducted this study to evaluate the growth, composition, and characteristics of the future personal communications industry through a survey of mobile communication's industry leaders. The results of the survey indicate the pace and extent of the second communications revolution as America moves into the next century.

History of this Study and Forecasting Methodology

In 1992, PCIA completed its first PCS Market Demand Forecast. Since its release, the report has been cited in Congressional hearings, quoted in trade media, examined by Wall Street analysts, and referred to by companies in the telecommunications industry to support market analyses. This year, PCIA updated the findings to reflect new data from over 100 PCS marketing and technical trials conducted in the United States during the last year and a half.

PCIA, which consists of over 450 companies engaged in developing services and products for the personal communications industry, defines personal communications service (PCS) as *"a broad range of individualized telecommunications services that enable people or devices*

to communicate independent of location." The PCS family of services includes New PCS 1800-2200 MHz, cellular, paging, SMR\ESMR, and dedicated data services. It is PCIA's view that PCS services will revolutionize the way people communicate, and bring wireless communications to a mass market through lower priced equipment and service charges.

PCIA solicited information from a qualified "key list" of PCIA member companies from our membership. Respondents include representatives from cellular carriers, paging carriers, network and CPE manufacturers, interexchange carriers, LECs, independent marketing research firms, government research agency data and PCS entrepreneurs. For the purpose of the survey, PCS demand was broken down into eight primary services: New PCS, cellular, paging, SMR/ESMR, dedicated data, satellite, wireless PBX, and cordless phone. Since Wireless PBX and cordless phone are not considered carrier services, this study focuses on the six primary carrier services.

A "key list" of industry experts provided data for each of the eight services regarding total anticipated service penetration, business penetration, equipment and service pricing for Year 1998 and Year 2003 (five and ten year forecasts). Respondents were also asked to indicate if information came from primary, secondary or company estimates. This year PCIA's responses included more primary and secondary estimates, reflecting better data available from market trials.

The methodology PCIA used tracks subscriptions to mobile services, not individual subscribers. The distinction is particularly important when reviewing aggregate subscriptions across services. Total subscriptions will always be greater than total subscribers because many individuals will subscribe to multiple services. Today, for example, there is a growing base of customers that utilize both paging and cellular. As the findings below point out, it is conceivable that PCS will open up new opportunities for customers to use new service offerings with multiple services. Statistical information was calculated using the consensus building Delphi method (removal of the high and low response, and averaging the remaining sample.)

The following primary findings have been prepared as an information resource for PCIA members, the financial community, federal regulatory agencies, and the public.

PCS Technologies Forecast

1993 - 2003

	1993		1998			2003		
Service	Subs. (millions)	Penetration (% of pop)	Subs. (millions)	Penetration (% of pop)	5 Yr. Subs. % Increase	Subs. (millions)	Penetration (% of pop)	5 Yr. Subs. % Increase
New PCS			8.55	3.1%		31.11	10.4%	263.9%
Satellite	0.1	.04%	1.32	0.5%	1224.0%	4.11	1.4%	210.8%
Paging	19	7.4%	36.8	13.3%	93.7%	65.3	21.7%	77.4%
Dedicated Data	0.05	.02%	3.36	1.2%	6630.2%	5.65	1.9%	67.8%
Cellular	13	5.0%	33.07	12.0%	154.4%	52.3	17.4%	58.1%
SMR/ESMR	1.5	.6%	5.19	1.9%	245.7%	8.95	3.0%	72.6%
Total PCS Services	33.7		88.3		162.4%	167.4		89.6%

The following US population figures were used: 1992/255 million; 1993/258.5; 1998/275.8 million; 2003/300.3 million.

Note: Total subscriptions includes individuals with multiple subscriptions across services (i.e. there are more subscriptions than subscribers).

Primary Findings

The attached "PCS Technologies Forecast" summarizes aggregate statistical findings for the six carrier based services. The primary findings were developed from these findings. The next section lists assumptions PCIA took into account in developing the analyses below.

The primary findings include the following:

o **All eight PCS Services studied will continue to grow, despite increased competition.** (See attached "PCS Technologies Forecast" page.) Available market research indicates that there is a very high amount of unmet demand for personal communications. Decreasing prices, advanced technologies, and creation of licenses will enable service providers to fill the demand gap.

o **Multiservice use is expected**. The complementary nature of PCS services will create a market in which users of one wireless service may adopt additional services to enhance overall functionality. For example, cellular users may adopt an alphanumeric pager for message screening and response queuing, or companies with many mobile workers already using PCS may install a wireless PBX. Since PCIA's results show that a person is likely to use multiple services, and the demand for more than one service per subscriber may be high, the forecasts refer to quantity of subscriptions, instead of subscribers.

o **The respondents see the New PCS as adding new value to the industry.** New PCS is not expected to replace any existing wireless technology studied, although increased competition will certainly affect the growth rate of the other services. Rather, respondents see the new services as adding new value to the industry by complementing existing services, and increasing demand for all wireless services.

o **A wide array of services is developing, each with its own specific functionalities, service mix and market advantages. These services each have varying price points and levels of technical complexity.**

o **Residential service growth:** New PCS will be heavily oriented to consumer service. Results show that business penetration for New PCS in Year 5 is a modest 30%, suggesting that New PCS will not necessarily

follow the traditional pattern of business to consumer migration; rather PCS may begin with the non-business or residential customer. Our results also showed paging, and to a lesser extent cellular, further expanding into the residential marketplace.

o **Data PCS:** As with the landline communications, data will comprise an increasing share of total wireless communications in the future. This was reflected by data services growth in cellular data (anticipated 2.69% penetration in 2003). Voice-plus-incremental-data is a strong component of New PCS demand, and participants projected over 70% of New PCS usage will include some type of data service.

o **Deployment:** Demand is dependent upon the timing of service deployment. The data illustrates that ESMR will grow earliest followed by CDPD, and finally New PCS voice and data service.

Assumptions

The following assumptions were used by the survey respondents in formulating their market estimates:

o Penetration is based on US population figures that assume 1.5% annual growth: 1992 / 255 million; 1993 / 258.5 million; 1998 / 275.8 million; and 2003 / 300.3 million.

o Recently we received end of year 1993 reported penetration and subscriber figures for New PCS, Satellite, Paging, Dedicated Data, Cellular and SMR/ESMR. Wherever possible, five and ten year growth figures use the 1993 figures as the baseline.

o Service descriptions and capabilities are based on definitions set forth in the *Telocator (PCIA) Service Descriptions Document for Personal Communication Services*. This document is available at PCIA.

o We assume the existence of a fully competitive environment, where services coexist simultaneously and the demand for one service may influence the demand for others.

o Existing services evolve into more mature services possibly offering greater functionality. For example, paging services evolve to advanced paging where customers are offered greater messaging capabilities. The survey matrices listed these services together and a single forecast was requested.

o Cellular, Advanced Cellular, ESMR, and New PCS share similar service descriptions. Although at the point of licensing these services may not all provide the same set of capabilities, it can be assumed that over time each will meet their full range of capabilities as described in the *Service Descriptions* document.

o Quantity of subscriptions was used; not quantity of subscribers. For instance, New PCS 1800 and other listed services may include a pager for call notification. Subscribers for such multiple services were counted as both a New PCS 1800 customer, for example, and a paging customer. When a single customer uses more than one type of service, the customer is included in each service count as one subscription.

Additional Note:

Coverage area requirement: The original survey and subsequent analyses did not stipulate a service coverage area requirement, or analyze its effect on demand. The industry knows first hand from PCS market trials, and from experience in cellular and paging, that coverage is one of the most critical factors in demand for a PCS service. In addition, the FCC has mandated that 90% of the population must be covered by the New PCS networks, by Year Ten.

The FCC's Second Report and Order on PCS

On September 23, the FCC's Second Report and Order ruled that the new spectrum in the Emerging Technologies Band would be allocated to the industry for PCS, and designated the market sizes service areas, and eligibililty. Seven new spectrum licenses per market are to be auctioned to the public for PCS service within the 1850-1970 MHz band and the 2130-2200 band. Of the licenses, two will be 30 MHz, one will be 20 MHz , and four in the upper band will be 10 MHz. The size of the service area corresponds to the Rand McNally designations of Basic Trading Area (BTA) and Major Trading Area (MTA) for the two 30 MHz licenses in the lower band. The licenses can be aggregated up to 40 MHz total. The Second Report and Order on PCS established operating rules including eligibility criteria for cellular carriers, and establishment of a 90% coverage requirement for PCS carriers by Year 10. For additional details on this ruling, please contact PCIA or the FCC.

Conclusion

The respondents of this survey and the PCIA membership have been waiting in anticipation for the rules and regulation that will govern PCS services to be finalized, so that business strategies and critical decisions can be made. As these important rulings are completed, PCIA is in a constant process of analysis, and we will continue to serve our members and the telecommunications community by producing industry forecasts as needed.

The US PCS industry is fortunate to have an FCC that supports rapid and efficient deployment of a new PCS industry. As New PCS ignites the second "wireless revolution", as paging and messaging services expand to

new markets, as cellular maintains a strong subscriber base and diversifies service offerings, and as ESMR offers new wide area coverage service offerings, PCIA members will continue to inform Wall Street, Congress, federal regulatory agencies, and US industry on technical and market developments that affect the wireless industry.

For more information, please contact the Personal Communications Industry Association at 202 467 4770 voice or 202 467 6987 fax.

Service Specific Findings

NEW PCS: Although New PCS will clearly start service later than other existing wireless services, dynamic growth is expected to continue for the next decade. With service deployment anticipated for approximately 1995, total penetration is expected to grow to 3.1% by 1998 (8.5 million subscriptions) and reach 10.4% penetration in 2003 (31.1 million subscriptions.) The Year 5 to Year 10 growth rate is projected at 264%, the highest maintained growth rate of the services studied.

PAGING: With a lower price point, demand for paging and messaging services will remain strong. Today's over 19 million subscribers are predicted to grow to 36.8 million by 1998, with a predicted total penetration of about 13%. (This indicates a 1993-1998 increase of 93.7%) Results suggest Year Ten penetration will reach close to 22%, indicating that over 46 million new paging/messaging subscriptions will be registered by 2003, many of which will be consumer or non-business. Paging maintains the largest market share, anticipating 65 million subscriptions in 2003.

CELLULAR: Demand for cellular services will increase dramatically from 13 million subscriptions in 1993 to 33 million in 1998, a 154% increase. Cellular penetration is expected to grow from a reported 5% penetration at year end 1993 to approximately 12% penetration in 1998 and 17.4% penetration in 2003. Cellular is predicted to have the second largest number of subscriptions in 2003: 52 million.

ESMR/SMR: Our respondents predict that ESMR/SMR use will be over 90% business based. Anticipated penetration in Year 5 is 1.9% (5.1 million subscriptions) representing a five year growth rate of about 246%. Year Ten results predict penetration of about 3% (8.9 million subscriptions). Customer premise equipment (CPE) prices are expected to be relatively high, ($467 average in 1998, dropping to $275 in 2003). This price level is second only to satellite CPE.

DEDICATED DATA: Anticipated to be positioned primarily for business users, our results show growth from 50,000 subscriptions in 1993, to 3.36 million in 1998, representing an increase of over 6600%. The results forecast about 5.6 million subscriptions by 2003. The

networks will provide added value through increased flexibility and mobility for those businesses that require such services.

SATELLITE: The highest priced of the PCS services examined, CPE price will be $1200 in 1998. Satellite service will be over 98% business, and will serve about 1.3 million subscriptions by 1998, and over 4 million subscriptions by 2003. Although satellite networks may have the fewest subscriptions of those we examined, the Year Ten growth registers at 211%.

WIRELESS PBX: Wireless PBX data in our survey had a relatively wide variance of responses on CPE price, monthly service charge, and penetration. This may suggest some confusion within the industry about this products' relative positioning. Based on data received this report does not make any conclusions about WPBX services.

CORDLESS: Nominal growth in the cordless market is anticipated, the product will remain a primarily residential product.

1994 PCS Market Demand Forecast

Personal Communications Industry Association

Primary Findings

- All 8 services will continue to grow despite competition.
- Multiservice use is expected.
- New PCS adds new value to industry (whole pie grows).
- Wide variety of service offerings expected.
- High potential for residential service growth.
- Data PCS - 70% of new services expected to offer data.
- Timing of service deployment expected to affect demand for specific services.

This report shows projected demand for PCS Services subscriptions for Year Five (1998) and Year Ten (2003).

The results were derived from a PCS industry survey conducted over 4 months by The Personal Communications Industry Association, (formerly Telocator.)

Over 30 companies involved in PCS responded to the survey.

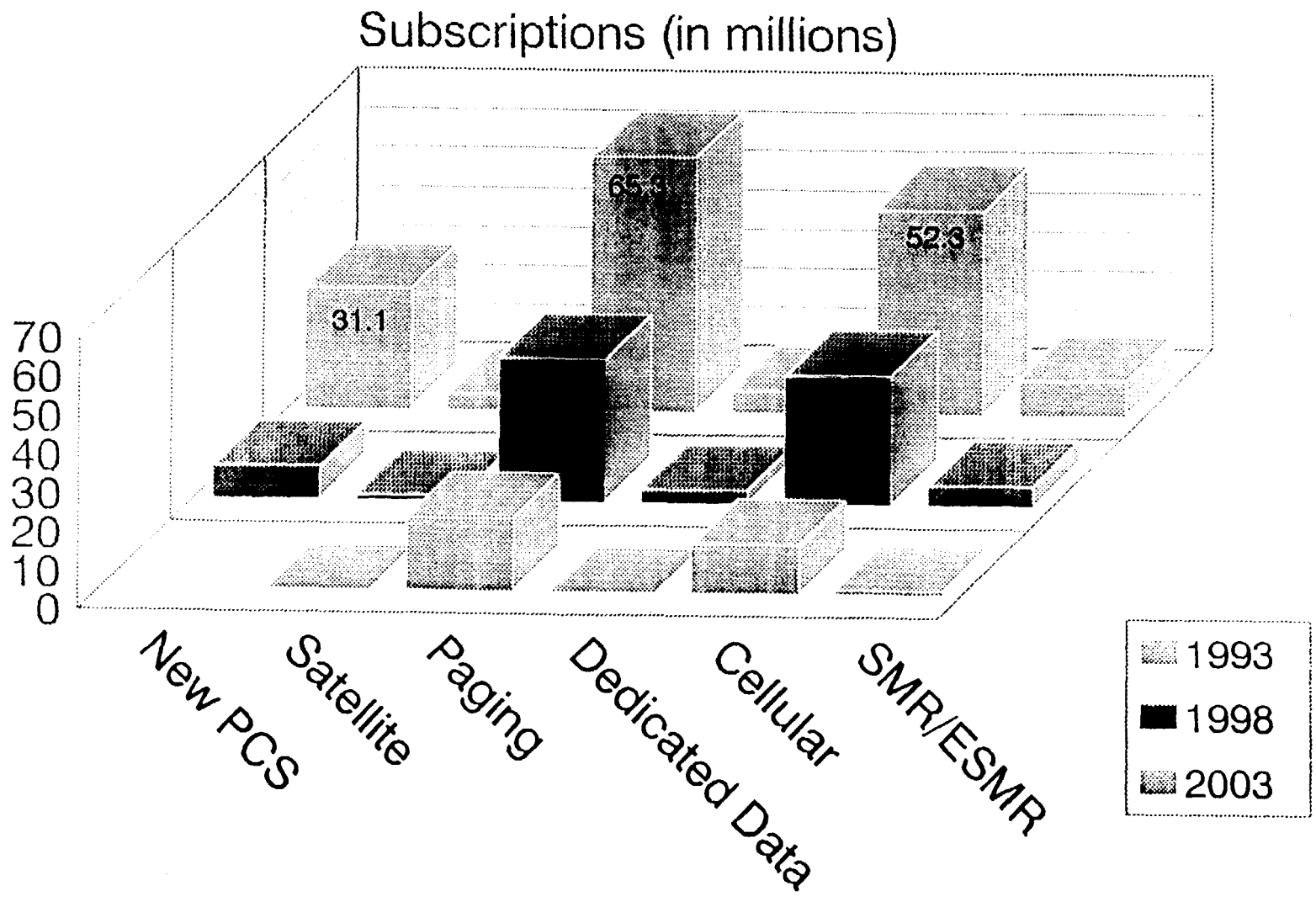
Results are provided in terms of population based penetration and quantity of subscriptions for each service.

Personal Communications Services (PCS)
is defined by PCIA as " a broad range of individualized telecommunications services that enable people or devices to communicate, independent of location."

PCS technologies examined in this report include:

- New 2 GHz PCS
- Satellite
- Paging
- Dedicated Data
- Cellular
- SMR/ESMR

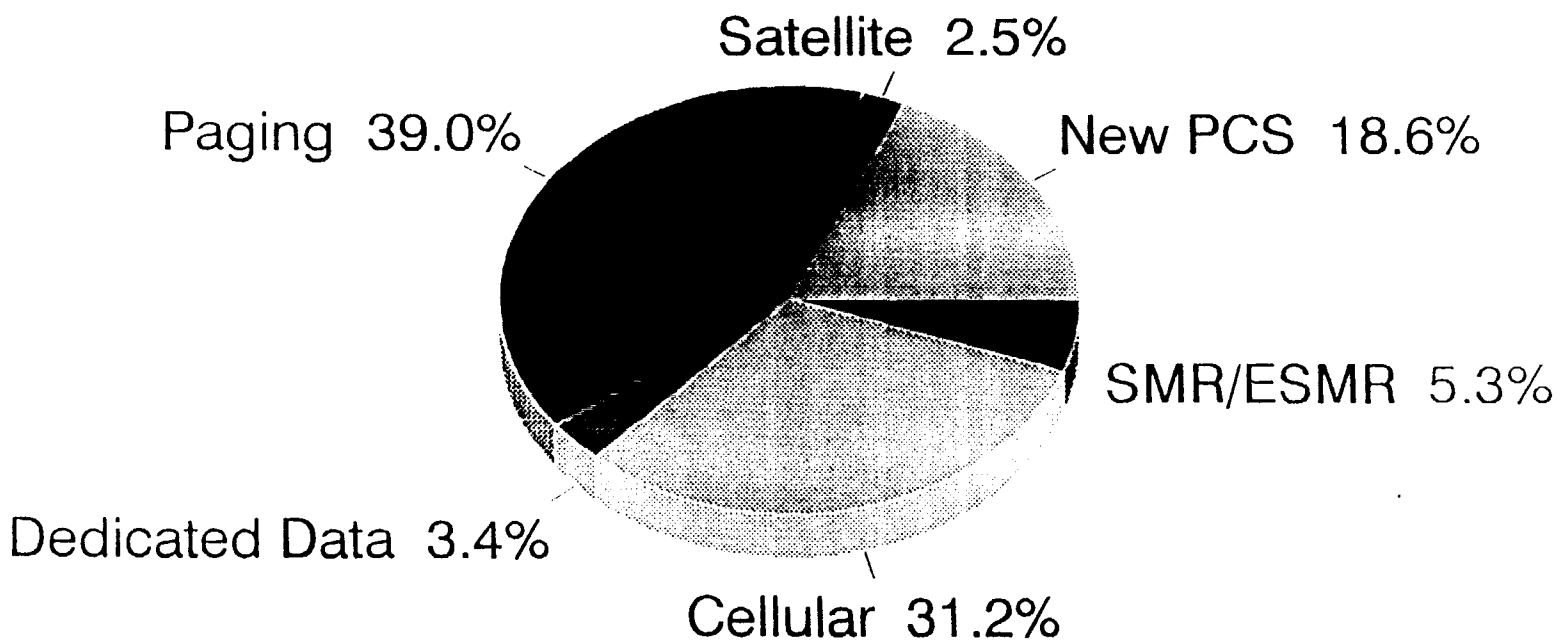
1993 - 2003 Total Subscriptions



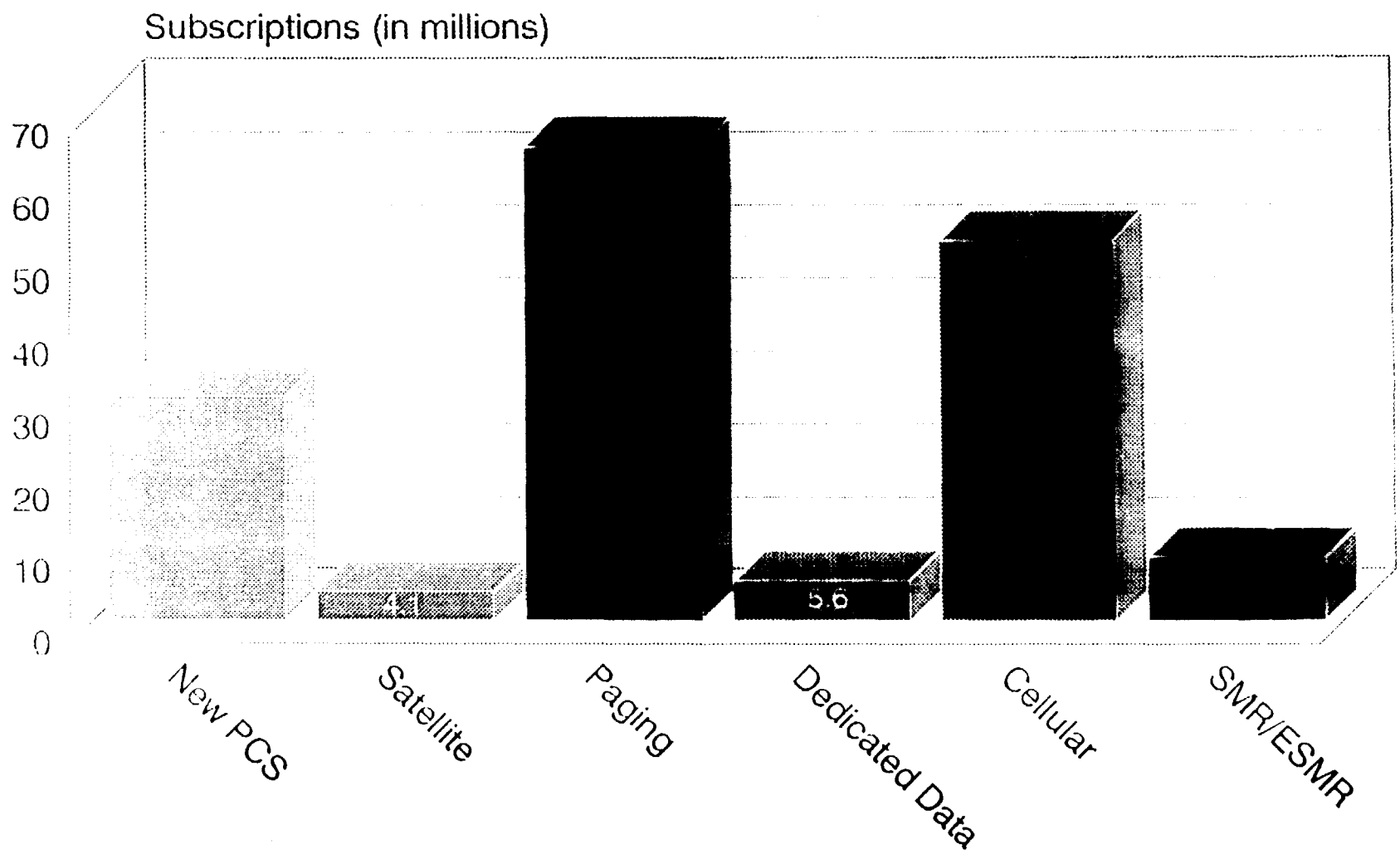
The Personal Communications Industry Association

2003 Wireless Demand Distribution

In Year 10 we forecast 167.4 million wireless subscriptions according to the following distribution:

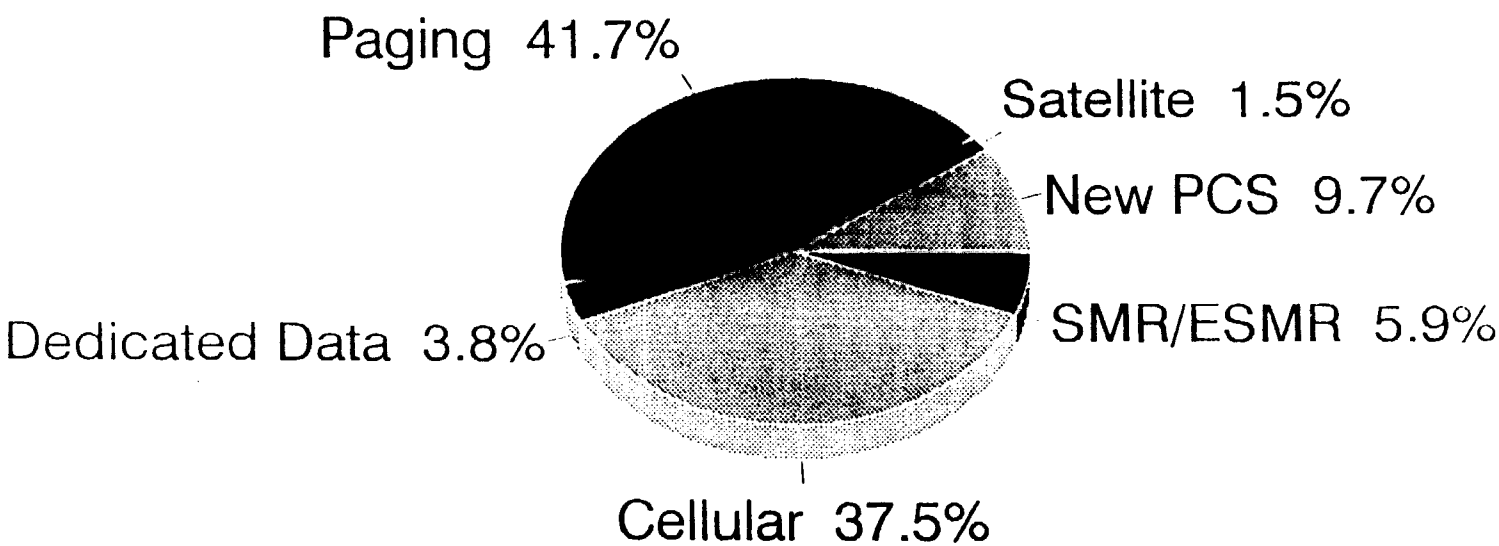


2003 Subscriptions Estimates

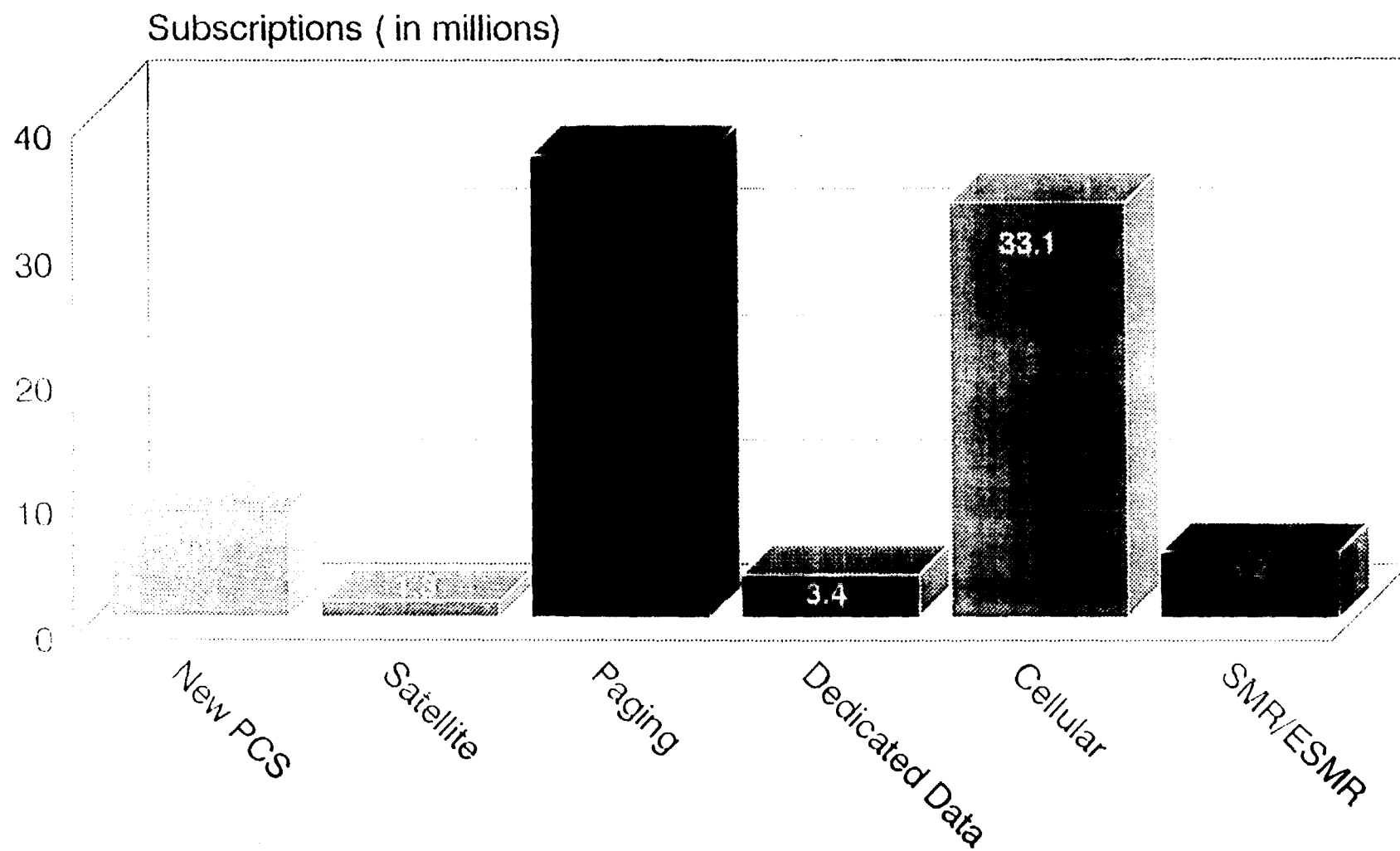


1998 Wireless Demand Distribution

In Year 5 we forecast 88.3 million wireless subscriptions according to the following distribution:

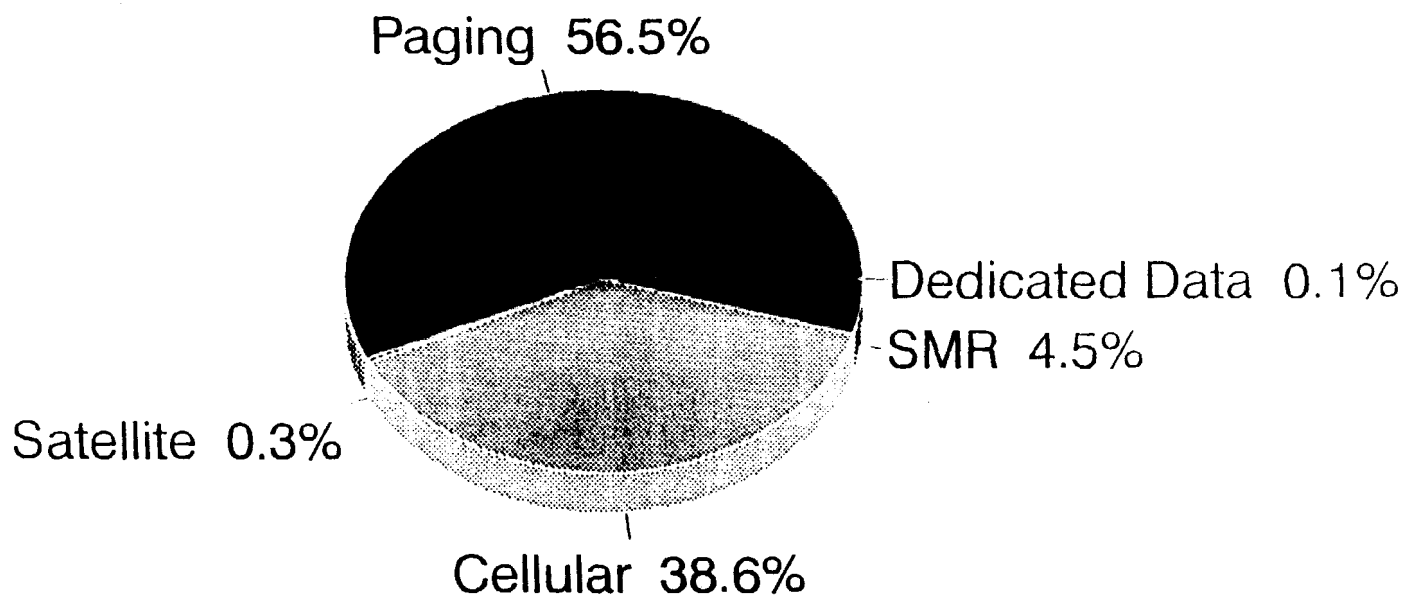


1998 Subscriptions Estimates

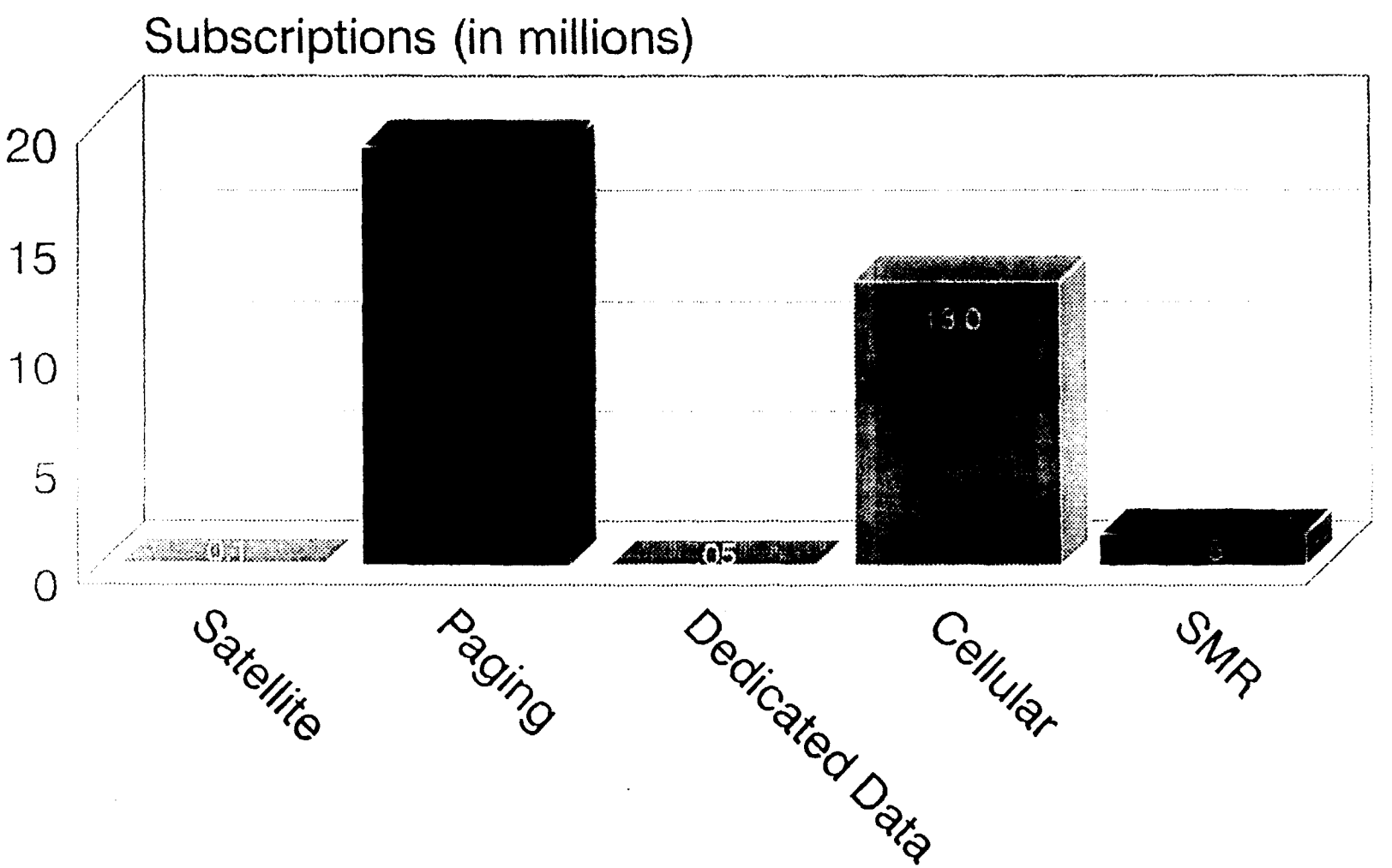


Total 1993 Wireless Demand Distribution

In 1993 there were 33.7 million wireless subscriptions according to the following distribution:



Total 1993 Subscriptions



The Personal Communications Industry Association